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ABSTRACT

Designed to answer basic questions educators have about microcomputer hardware and software and their applications in teaching, this paper describes the revolution in computer technology that has resulted from the development of the microchip processor and provides information on the major computer components; i.e.; input, central processing unit, memory, auxiliary storage, and output. The cost and timesaving advantages of a microcomputer purchase are discussed, as well as the instructional advantages, and the various types of teaching strategies used with a computer are explained. The paper also includes a discussion of hardware selection criteria, software selection sources, and organizations which can provide the novice computer user with helpful information. (LLS)

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MICROCOMPUTERS IN EDUCATION

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To The

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Microcomputers in Education

Newsweek magazine recently stated that "We are at the dawn of an era of the smart machine - an information age that will change forever the way an entire nation works, plays, travels and thinks. Just as the industrial revolution dramatically expanded the strength of man's muscle and reach of his hand, so the smart machine revolution will magnify the power of the brain " (Newsweek, June 30, 1980). The smart machine Newsweek was speaking of, refers to the development of the computer which uses the microchip processor. The tiny silicon chip can be etched with computer circuitry which is powerful enough to schedule seating on an airline, as well as, teach children to spell, solve problems, or simulate an internal combustion engine. This revolution will be so pervasive in our society that authorities predict there will come a time when an inability to use computer technology will render an individual at a severe disadvantage in the office, at home and in school. With microcomputers becoming more prevalent in everyday living, educators, parents, and children alike find themselves confronted with a piece of machinery of which they have little understanding and no operating experience. We can no longer afford to remain computer illiterates, that is if we plan to be able to compete in or cope with today's world.

Because the microchip has made computer technology more compact, flexible, and less costly, the use of the microcomputer for educational purposes has become more feasible. In 1977 when the microcomputer was first introduced to the market, only 3,000 units were sold. This year, manufacturers estimate that over 50,000 micros will be used in the classroom.

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If the microcomputer is to become useful in teaching, then those of us in education need to know what applications it has in teaching and how to select computer hardware and software which is suitable to our needs. In addition, we need to know what informational resources are available to make our knowledge of computers more complete. Hopefully, this presentation will answer some of these questions.

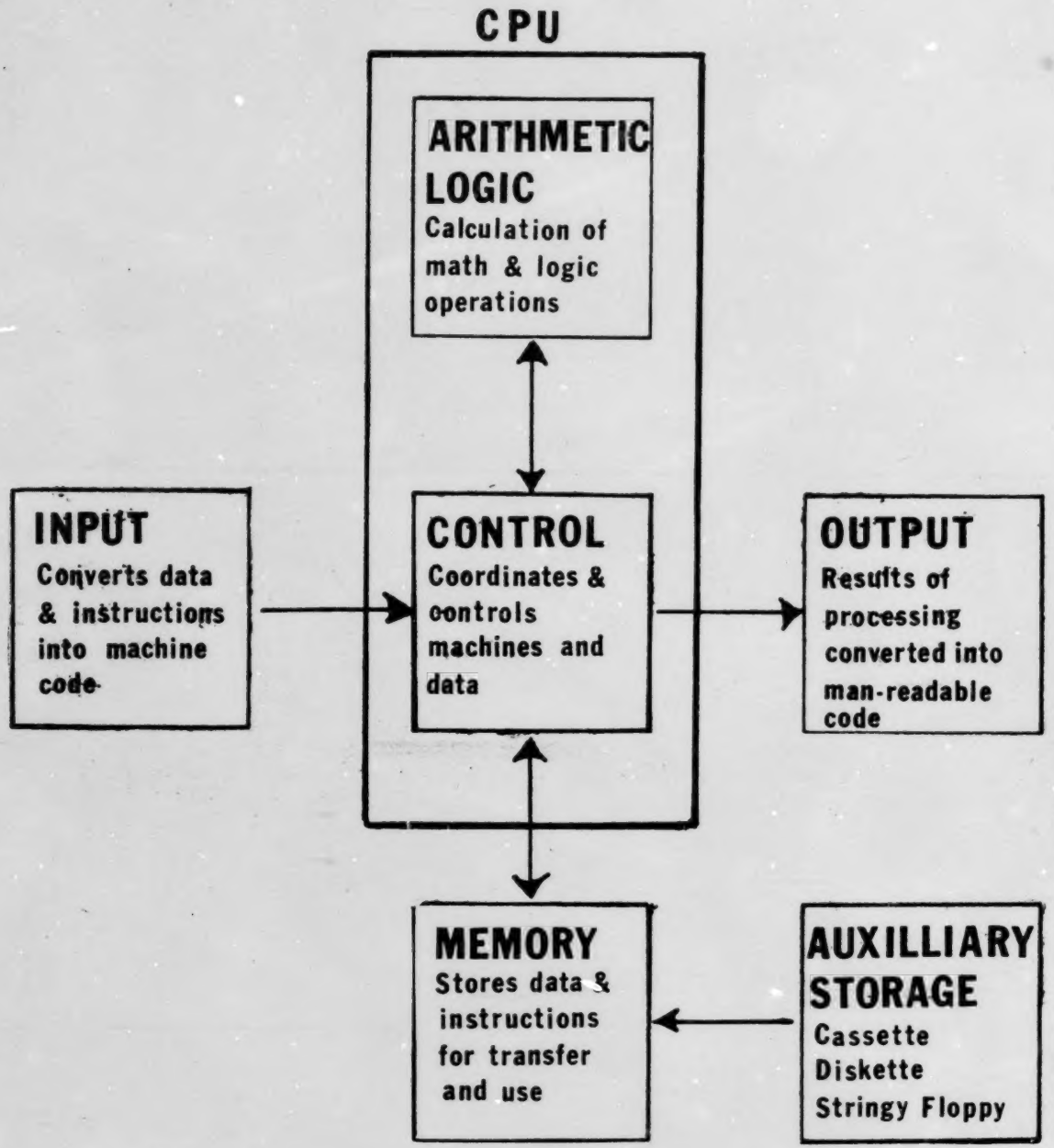
First, let us find out what a microcomputer is. Before we start, it must be clear that a computer cannot function without people. Basically, computers are stupid and require some instruction or input from people in order to run.

A diagram of computer components will help us in our understanding of what a computer is and what it can do (fig. 1). The components we will be discussing include: input, central processing unit, memory, auxilliary storage, and output.

Inputing instructions is done several ways. Most of us are well aware of the use of computer punch cards to input information as we receive these in the mail with our phone bills. However, a microcomputer uses a keyboard similar to that of a typewriter to input information. Generally, this information is put into the form of a computer program.

The microcomputer functions the same as a large computer. The major difference lies in the use of a microprocessing chip which contains the central processing unit. A CPU, so called by computer buffs, interprets the instructions and controls the flow of information to and from the other components of the computer. It also contains the arithmetic logic unit (ALU) which functions as the computer's calculator.

Figure 1


CPU
ARITHMETIC LOGIC
Calculation of math & logic operations
INPUT
Converts data & instructions into machine code
CONTROL
Coordinates & controls machines and data
OUTPUT
Results of processing converted into man-readable code
MEMORY
Stores data & instructions for transfer and use
AUXILLIARY STORAGE
Cassette
Diskette
Stringy Floppy

Most people do not realize how compact the inner worksings of a microcomputer really are. This minature computer is as power ful as the first ENIAC computer, built in 1948 that filled an entire room. The miniaturization is due to the use of a silicon chip which is engraved with complex circuitry. This chip is smaller than a finger nail.

When information is put into the computer, it is stored in memory. Two kinds of information can be stored: instructions which tell the computer what to do and data which are temporarily stored in memory for later use. Instructions must be written in a language or code which the machine understands. Microcomputers use the BASIC language. The CPU then interprets the code and translates it into binary digits or machine code. The CPU will then have the computer do such things as "print a word"; "run a program"; or "perform addition".

How much data can be stored is dependent upon the size of the microcomputer's memory. Memory size in a microcomputer is measured using the symbol K which represents 1,000. Thus a 4K machine would have 4,000 bytes of memory. A byte represents 8 bits or one character. A bit is a binary digit of one or zero. Microcomputers have memory ranges from 4K to 64K.

There are two kinds of memory in a computer. The first is Random Access Memory or RAM. Data and instructions can be placed in RAM for temporary storage. Sometimes RAM is called useable memory; it is this memory which is used for programming. However, once the microcomputer is turned off, the RAM will forget all the data and instructions which were placed in it.

The second type of memory is Ready Only Memory or ROM. This

memory has been engraved into the microchip. It cannot be erased and additional information cannot be added. The language used by the computer is stored in ROM.

If RAM forgets what is programmed into it, then how can programs be saved? Instructions and data can be saved in auxilliary storage for use at a later time. When using microcomputers, one can use cassette tapes, stringy floppys, or floppy disks to store programs.

Audio cassette tapes are the most common form found in classrooms. One only needs an inexpensive cassette recorder, hooked up to the microcomputer, to be able to record and playback tapes. There are certain drawbacks to using the cassette system:

1. They are only capable of handling linear or sequential programs.
2. Loading cassette programs can be tricky. Not only is the volume level crucial, but twisted tape and oxide flakings can result in bad loads.
3. A cassette is much slower in loading than any other storage device. The tapes are inexpensive, however, and are relatively easy for students to use.

A disk system consists of a floppy diskette which resembles a small, flexible phonograph record and a disk driver which allows the data to be read. The floppy diskette is made up of magnetic material. This equipment has several advantages:

1. It is must faster at loading and saving programs than a cassette tape.
2. Data can be randomly accessed, therefore, branching programs is possible.

The major drawback is the price. The system may require the purchase of an expansion interface or an interface card. This may cost up to 450. The diskettes are around $5 a piece. Purchasing a disk system for each microcomputer can be expensive, however, there presently exists a networking system which will allow up to 16 microcomputers to work off of one disk drive. The cost of the network is approximately $500.

Now there is another storage system available: EXATRON's stringy floppy. This sells for $250 and requires no expansion interface. The stringy floppy uses a small continuous wafer about 1/4 the size of the cassette. It comes in various lenghts; the 4K holds 4,000 bytes of information and takes 4 seconds to load. The stringy floppy is a good compromise between the inexpensive, but slow cassette and the fast, but expensive disk. Unfortunately, most software available is on cassette or diskette.

The output of the microcomputer consists of a Cathode Ray Tube (CRT) similar to the television tube of which we are all so familiar. The CRT displays the computer output, but will also display what is being input into the computer. This makes it easier to catch. Many microcomputers are sold with the capability of being hooked up to your television set at home. Particularly the computers which have color and high resolution graphics capability.

If you care for a hard or printed copy of your output, then a printer can be used. Some printers require an expansion interface device. One can get upper and lower case printers as well as printers which rival the quality of an IMB selectric typewriter.

Audio output can be achieved with a voice synthesizer. Phonemes are stored on microchips contained within the piece of equip-

ment. The speech is crude, but it is distinguishable.

This completes our discussion of the basic components of a microcomputer. This is probably more information than you ever wanted to know about the technical aspects of a computer. But you will find it necessary to know a few technical facts before you make a microcomputer purchase.

Now let us move on to two important questions: why buy a microcomputer and what advantages does one have for the educator? There are many good reasons for buying a microcomputer. The first is cost. A microcomputer can cost between $500 and $3,000 depending upon the brand, memory size and capability. This is inexpensive compared to the large timesharing systems used by schools and universities. Radio Shack suggests that such a large system would cost $11.96 per student as compared to 62¢ per student hour for a 16K micro system with a disk drive. In addition, buying a micro is a one time expense which is untrue of a timesharing system.

The microcomputer is also a great time saver. Most teachers spend a good deal of time record keeping. Presently there are several software programs which can be used to take over the mundane tasks of grading, taking inventory, scheduling, compiling data etc. Another time saving factor is the computer's ability to do advanced statistical analysis. It can also be hooked up to a large information network via a telephone and as a result, information can be retrieved from large data banks. A true time saver is the micro's ability to be used as a word processor. Documents can be typed directly into the computer; spelling can be corrected and the body of the text can be changed without retyping the entire text. Once the document is as desired, it can be printed out using a line printer.

In terms of instruction, the microcomputer can do many things for the student. It can allow the student to work at his or her own pace; it can provide immediate feedback as to the correctness of the response; it can monitor student progress and determine if remediation is required. In other words, the microcomputer can help individualize instruction.

The types of teaching strategies which one can use with the computer are many:

1. Drill and practice is required in the teaching of many basic skills and you will find that a micro is an ever patient teacher .
2. Problem solving can provide students with an opportunity to apply principles of math or science to a given situation.
3. Tutorial programs can present text information to a learner and then question the learner concerning the content, branching to other areas based upon the learner's response.
4. Simulations based upon real life models can help a student address a world problem like overpoulation or simulate the flight of an airplane without endangering the learner, and at the same time provide feedback concerning the consequences of the learner's actions.
5. Testing with the computer can allow the teacher to develop a pool of questions which the computer can select at random and present to the student. The student's response can be scored and results can be fed to the student immediately.
6. Computer managed instruction uses the computer to test and prescribe certain activities based upon the results.

Based upon what we have learned about the components of a microcomputer system and how the computers can be used in education, it is possible to develop some criteria for the purchase of a system. When looking at a system, you will find that all microcomputers are not alike. Each one does different things well, thus, it is best to judge a microcomputer based upon its intended use. The first step is to identify your instructional and management needs for now and for the future. These needs can be translated into equipment capabilities.

The following equipment capabilities must be considered:

1. Memory size which may range from 4K to 64K.
2. Character set: meaning upper and lower case letters, number of letters per line, and number of lines allowed on the display.
3. Graphics capabilities like color, or high and low resolution graphics.
4. Auxilliary storage systems: disk, cassette, stringy floppy.
5. Languages used by the computer: BASIC or PASCAL
6. Expandability of the system: availability of printers, phone modems, graphics tablets etc.

In addition to equipment capabilites, other considerations include:

1. Cost: not only of the basic components, but of the full range of hardware you will require.
2. Ease of use and sturdiness.
3. Manufacturers reputation and service contract.
4. Availability of documentation like reference manuals and programming texts.

5. Availability of software which is probably the most important factor, particularly, if you plan to use the microcomputer for any thing other than programming.

The software you select must be compatable with the microcomputer you own; this is why it is critical to look at available software before you purchase the hardware. Where do you look? You will find that well know book publishers such as Scott Foresman, Miliken, and S.R.A. are entering the "electronic publishing" field. Begin by checking their new catalogs. Becuase of their reputation as quality book publishers, most of their computer software will probably be high quality.

Besides book publishers, the hardware dealers like Radio Shack and Atari have limited amounts of software. Most perform management type functions, however, some educational programs are availablle. Independent software dealers often advertize in magazines such as Creative Computing or Personal Computing. These magazines ofter review various software programs in addition to publishing program listings. For educators there are other magazines such as the Computing Teacher which publish educational programs as well as provide an opportunity for idea and software exchanges. Finally, there are users groups established for almost every computer type on the market. Usually the meetings are publicized though the local hardware dealers. These groups offer an opportunity to meet other "computer buffs" and a chance to exchange software. At present the software development is well behind that of hardware, but it is only a matter of time before the market is flooded.

There are also a number of organizations which can help you obtain more information about the uses of computers in education.

These include: Association of Educational Communications and Technology (AECT), Association of Educational Data Systems (AEDS), and in Texas there is now a Texas Computer Education Association. These organizations can provide journals, newsletters, guides, as well as workshops and conferences which address the issue of microcomputers and their uses in education. AECT has recently published a Guide to Microcomputers and in the September 1980 issue of Instructional Innovator you will find the entire issue dedicated to the subject. Here you will find selection advice and a list of resources which will be helpful in your quest to obtain more knowledge about microcomputers.

As professionals in the field of Educational Technology, people will come to us for advice concerning the potential of microcomputers in teaching and in management. It is in the best interest of our profession that we learn something about micros. We must learn so that we can teach others, particularly, inservice and preservice teachers, not to fear the advent of the computer in the classroom, but to learn to use it as they would any other teaching tool.